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A CENSUS OF THE CALIFORNIA GRAY WHALE

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A CENSUS OF THE CALIFORNIA GRAY WHALE

by

Raymond M. Gilmore
Formerly, Biologist, Marine Mammal Research

[Edited by Dale W. Rice]

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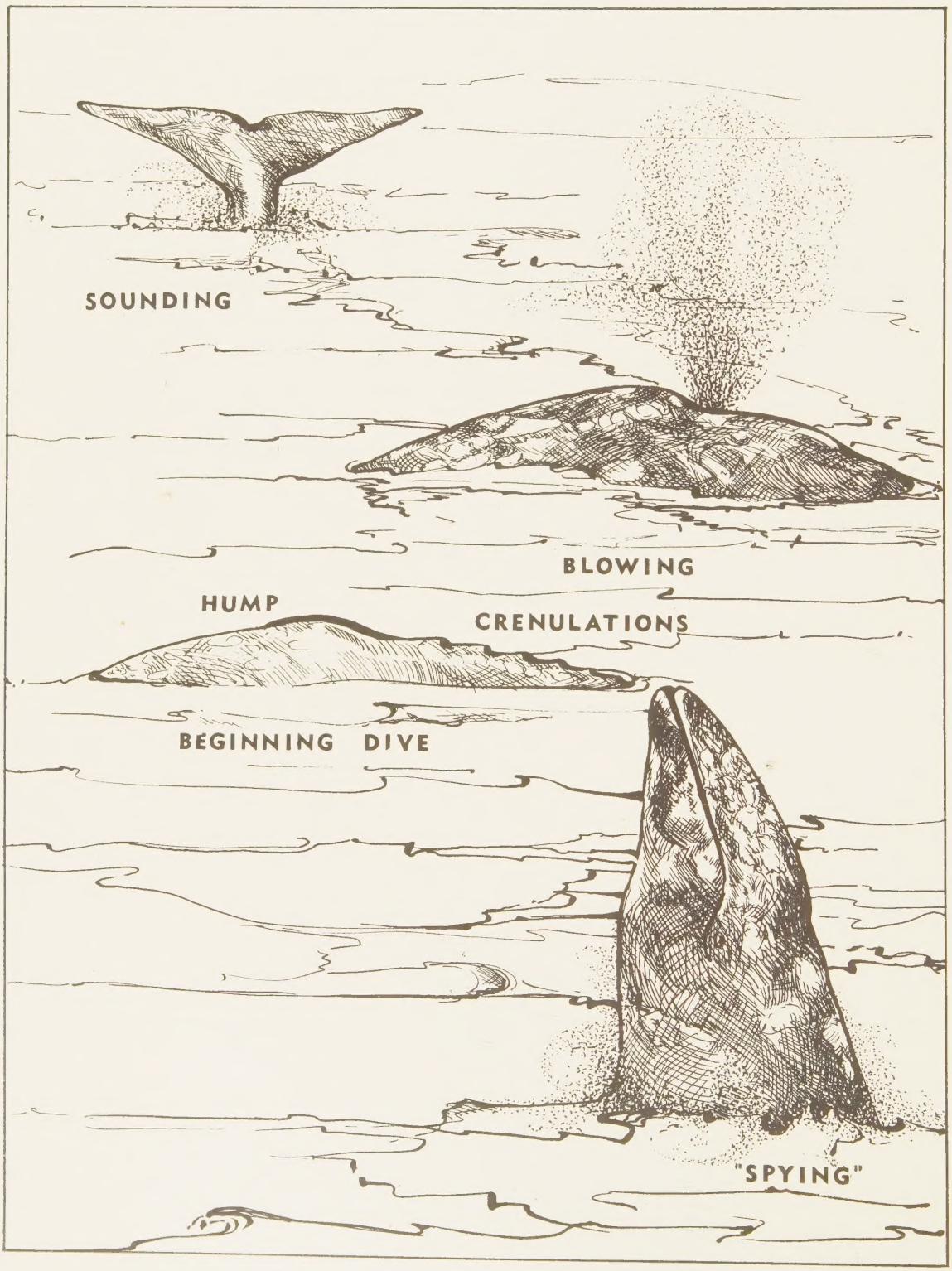

Frontispiece: Identification features of the gray whale.

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SUMMARY

Gray whales, *Eschrichtius gibbosus* (Erxleben) 1777, were originally three isolated stocks, termed the Atlantic, California, and Korean populations. The Atlantic population has long been extinct; the Korean population has been severely reduced in numbers. The present study concerns only the California population.

Most California gray whales spend the summer (June through September) in the northwestern Bering Sea and the Chukchi Sea. A few summer along the coast of northern California and southern Oregon.

The southward migrating whales strike the Pacific coast of North America between Vancouver Island and San Francisco. They then travel within about 4 miles of the shore until they reach Baja California. A few are believed to leave the coast at Point Conception, moving past the offshore side of the Channel Islands before striking the coast again south of San Diego. Most southbound whales pass San Diego between the middle of December and the middle of February.

In winter (early January to the end of February) gray whales are scattered along the Pacific coast from about San Diego to Cabo San Lucas, and in the southern end of the Gulf of California. A few stragglers have been observed in the northern Gulf and at Guadalupe and Clarión Islands as well as at various points as far north as the coast of British Columbia.

Calving takes place in shallow lagoons, bays, and esteros. The five important calving areas are: (1) Vizcaíno-Scammon; (2) San Ignacio and (3) Magdalena, along the Pacific Coast of Baja California; and (4) Yávaros and (5) Reforma, on the east shore of the Gulf of California. San Diego Bay, California, is no longer a calving area.

The northbound migrants pass San Diego mainly in March and April. They move along the coast, and many pass the west side of Vancouver Island before turning off into the North Pacific.

The rate of migration is fairly uniform throughout the day. Movement apparently is slightly greater in the afternoon, when the fog tends to lift. No data are available on rate of migration at night. For census purposes, movement at night is held to be 50 percent of the daylight rate of 4 knots.

Gray whales are not strongly gregarious during migration. They usually travel singly or in groups of two or three. Singles, presumably pregnant females, are common in the early stages of the southward migration.

Immature individuals and nonbreeding adults predominate in the outer channels near the entrances of breeding lagoons; pairs and trios of courting adults predominate in the intermediate areas, and cows with calves predominate in the inner "nursery" areas.

Adult cows bear one calf at 2-year (or longer) intervals. Gestation apparently lasts 11 to 12 months.

During a 4-season study in Laguna Scammon, 12 dead calves and 2 dead adults were found. The mean length of 7 calves, measured in January and February, was 13.25 feet.

From 1850 to 1890, whaling operations along the coast of California and Baja California reduced the California gray-whale population of 25,000 to 50,000 to perhaps a few thousand. From 1890 to 1924, the population

increased. From 1924 to 1937, whaling was again carried on. Since 1937, the species has had complete legal protection.

Counts of gray whales during their southward migration past San Diego, in the seasons 1952-53 through 1956-57, suggest that the population is increasing, possibly as much as 10 percent a year. The estimated population, including corrections for whales passing unseen during periods of darkness and poor visibility, and whales passing offshore, was 2,894 in 1952-53 and 4,454 in 1956-57.

Aerial censuses of the winter range indicate the extent of the breeding grounds and their relative use by whales. The most important areas are: (1) Vizcaíno-Scammon, with 1,500 to 2,000 whales (about half the total population); (2) San Ignacio, with about 500 whales (one-eighth to one-sixth the total population); and (3) Magdalena, with 1,000 to 1,500 whales (about one-third the total population).

A CENSUS OF THE CALIFORNIA GRAY WHALE

INTRODUCTION

OBJECTIVES

The main objectives of this study have been (1) to estimate the size of the total population and its present rate of increase, (2) to determine the extent of the breeding grounds and their relative importance, (3) to determine the time and nature of the southward migration past California, and (4) to establish a basis for detecting, in the future, any unusual changes in population size.

The study was carried on by the author for five years. With minor exceptions, biological information based on specimens was not obtained. The International Convention for the Regulation of Whaling, which protects the gray whale, provides for taking scientific specimens. Exact information on age and reproduction can be obtained in the future from specimens. Observations in Bering and Chukchi Seas will be needed to provide information on food habits as well as refinements in knowledge of migration routes.

ACKNOWLEDGMENTS

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Special thanks are due to C. L. Hubbs and G. C. Ewing, both of Scripps Institution of Oceanography. The contributions of these two will be explained in the text.

TAXONOMY AND DISTRIBUTION OF THE GRAY WHALE

TAXONOMY

The scientific name of the gray whale has been changed several times in the past 30 years. The living species commonly called the gray whale was long known by the specific name *Agaphelas glaucus*, given by Cope (1868). Later (1869) Cope placed the species *glaucus* in the new genus *Rhachianectes*. *Rhachianectes glaucus* means "the gray swimmer along the rocky shore," and a more fitting name hardly could have been coined. However, a prior name existed which would eventually be recognized to include *glaucus* and by the internationally recognized rule of priority, *Rhachianectes* has been superseded. To Tomilin (1957), Cope's name for the living gray whales of the Pacific is antedated by the name *Balaena agamachschik* Pallas, 1811.

In 1937, subfossil bones of gray whales, believed identical with the living species, were described in detail by van Deinse and Junge, from Recent deposits in the drained polders of the Zuider Zee, Holland. These investigators identified earlier-described fossils from Sweden and England, which possess names that antedate *glaucus*, as those of the living species of gray whale.

One of these early names for a fossil gray whale from Gräsö, Sweden, in the Gulf of Bothnia, was *Balaenoptera robusta* Lilljeborg, 1861. Three years later Gray (1864) set up a subgenus *Eschrichtius* with *robusta* as type species. Later (1865), Gray raised *Eschrichtius* to generic rank, and Lilljeborg followed suit, calling the Gräsö whale *Eschrichtius robustus*.

Van Deinse and Junge, however, discovered an even earlier name, *Balaena gibbosa* Erxleben, 1777, based on the "scrag" whale of New England origin and first mentioned by Dudley in 1725 with a description suspiciously like the gray whale, which stated, "A *Scrag Whale*. Is near akin to the Fin-back, but instead of a fin upon its back is scragged with half a dozen knobs or knuckles. He is nearest the Right Whale in figure and quantity of oil. His bone [whalebone] is white but wont split." Van Deinse and Junge applied the name *Eschrichtius gibbosus* to all populations of gray whale, living and extinct, thus assuming that the gray whale lived on the New England coast in the 18th Century. The gray whale has never been known, either from other reports or from specimens, to inhabit the entire western North Atlantic.

This action proved too much for Schevill (1954), who termed the "scrag" whale and its name *gibbosa* a "literary curiosity." In a neat turn of logic, he stated that if the fossil gray whales could not be shown different from the living form, as stated by van Deinse and Junge, then, neither could they be shown identical, presumably because soft parts were not examined and complete fossil skeletons were not available. Schevill thereby held *Eschrichtius robustus* to be the proper name for the fossil specimens from the northeastern Atlantic, and *E. glaucus* for the living form of the Pacific. In this he was followed by Miller and Kellogg (1955).

Such reasoning can lead only to taxonomic chaos. Until morphological differences have been demonstrated between the extinct Atlantic and the living Pacific populations, a single name must be applied to all populations. It is unlikely that the populations were more than subspecifically distinct, at most. At any rate, the name *glaucus* Cope would be invalid for the Pacific populations because the name *agamachschik* Pallas has priority.

The name *Eschrichtius gibbosus* Erxleben, 1777, has been adopted by most recent authors (e.g., Cederlund 1939; Ellerman and Morrison-Scott 1951; Tomilin 1957; Slijper 1958). Although this name rests on a somewhat debatable basis, it is used by the present writer. If this name were rejected, the correct name would become *Eschrichtius agamachschik* Pallas, 1811. Such action would be unfortunate as Pallas' name was overlooked for many years and has never been used by other authors.

DISTRIBUTION

There are two distinct populations of living gray whales: one known as the California population, in the eastern North Pacific; the other, known as the Korean population, in the western North Pacific. A third population, now extinct, occupied the eastern North Atlantic (fig. 1).

There is some evidence that the two Pacific populations have not mixed in the 20th Century (Andrews, 1914). Zenkovich (1934) believed that the east coast of Kamchatka was, in his time, unoccupied by gray whales in summer and constituted a large unbridged gap between the respective summer ranges. Risting (1928), however, reported a catch of gray whales made on the east

Figure 1.--Distribution of gray whale.

coast of Kamchatka. Thirty-one whales (19 males, 12 females) taken from July 27 to August 22, 1925, with Nathalia Bay as a base, ranged from 25 to 36 feet in length. This was a smaller and younger group of whales than was taken by the same vessel from Bahía Magdalena, Mexico. Risting believed they had migrated from Mexican, rather than Korean, breeding grounds. Sleptsov (1955) stated that the populations "probably mixed before each herd was reduced to very low figures."

Distribution and migration of the California population will be discussed in detail in the next chapter.

Gray whales of the Korean population spend the summer in Okhotsk Sea. The same whales were reported by Scammon (1874), Andrews (1914), and Mizue (1951) to spend the winter in the waters of South Korea, and perhaps the Yellow Sea. These whales apparently calve in the channels, inlets, and bays along the rocky coast of South Korea.

Fraser (1937) reported that gray whales were taken with nets by the Japanese as far back as the 17th century, but the harvest was unimportant. After 1903, gray whales were captured in unrestricted numbers by modern whaling equipment and by 1938 the population was so low that all further whaling ceased because it was unprofitable. There are no estimates of the number remaining when whaling stopped.

Subfossil remains of gray whales of the Atlantic population have been unearthed from Recent deposits at three localities in Europe: (1) Gräsö, Sweden; (2) Cornwall and Devon, England; and (3) Zuider Zee, Holland (van Deinse and Junge 1937). The gray whale apparently survived into historical times off the coast of New England, where it was captured by early 18th century whalers under the name "scrag" whale (Dudley, 1725).

DISTRIBUTION AND MIGRATION OF THE CALIFORNIA POPULATION

SUMMER RANGE

Most California gray whales apparently spend the summer in the Arctic--in the Bering and Chukchi seas. No gray whales have ever been followed from one ground to the other, nor marked in one area and recovered in the other. However, the times of disappearance and reappearance of gray whales in the winter grounds off Baja California and in the summer Arctic grounds, along with the direction of movement, lead to the assumption that these whales are of the same herd. A few have recently been found in summer on the coast of northern California and southern Oregon.

Bering-Chukchi Area

No studies of gray whales were conducted in the Bering-Chukchi area during the present investigations. According to Zenkovich (1934) and Sleptsov (1955), gray whales arrive in northwestern Bering Sea and Chukchi Sea in June and stay through September. Ichihara (1958) reported a single gray whale in Unimak Pass on May 29, 1957, and another seen from a whale catcher on July 28, west of St. Lawrence Island. Also, on August 2, between 63°34'N., 172°48'W. and 63° 54'N., 170°50'W. (west of St. Lawrence Island) three groups consisting of 3, 20, and about 150 gray whales, 36 to 41 feet in length, were seen and photographed by Keiji Nasu of the Whales Research Institute. The larger aggregations were divided into smaller groups of one to three whales.

California-Oregon Area

A whaling company operating out of Humboldt Bay, California, in the 1940's, found a small herd of gray whales

spending the summer around Crescent City, St. George Reef, and Pelican Bay, Oregon, 75 to 100 miles north of Humboldt Bay. In September 1947 and June 1948, the writer saw 12 to 15 gray whales in Pelican Bay.

SOUTHWARD MIGRATION

California gray whales, in the course of their southward migration, are assumed to move across the open waters of the North Pacific from the vicinity of the Aleutian Islands to the coast of the United States. They reach the coast at points well north of San Diego, and even north of San Francisco. Gordon C. Pike (in lit.) has stated that south-migrating gray whales strike the North American coast at a point south of Vancouver Island. Most of them travel close to shore. The main migratory path is several miles wide and usually within one to three miles from shore. Gray whales have not been recorded migrating south at sea, far off the coast of southern California or off Baja California (figs. 1 and 2).

However, some gray whales do migrate southward offshore, since they have been seen at Isla Guadalupe and Isla Clarión. The route used in reaching these islands is not known. It has been suggested, with little factual basis, that the same whales may move along the Santa Barbara (or Channel) Islands, San Miguel, Santa Rosa, Santa Cruz, Santa Barbara, Santa Catalina, and San Clemente. Gray whales have been seen approaching land at La Jolla, and off the Coronado Islands, 12 miles south of Point Loma. Others have been seen from aircraft, making their way southward toward the mainland from the tip of San Clemente Island. Records of offshore movements are so few that any attempt to outline routes must be largely speculative.

Southbound gray whales are usually seen at San Diego during the latter half of November, though not commonly until after the middle of December. The bulk of the population passes in January, mainly during the middle two weeks of the month. By mid-February, the southward migration is virtually over, although a few stragglers have been seen moving south as late as March 25.

The intensity and duration of the southward migration are illustrated in figure 3. Here are shown the number of whales counted daily at San Diego, with extrapolation for whales passing unseen during the day because of bad weather, during the period from December 19, 1954, to February 15, 1955. (In preparing this figure, no extrapolation was made for whales passing unseen at night. See page 21.) Earlier, from November 19 to December 18, 28 whales were seen and another 56 estimated, or a total of 84. Later, from February 16 to 28, 8 whales were seen and another 8 estimated, or a total of 16. The whaling vessel *Vega* (Risting 1928) began whaling on November 14, 1924, in Bahía Magdalena but took only humpback whales until December 27, when the first gray whale was captured. In 1925 and 1926, the first gray whales were taken on December 29 and December 28, respectively. Migrants began to arrive regularly on January 4, the migration reached its height on January 22, and the last whale was taken on February 16. The first arrivals were pregnant females. Males gradually became numerous in January. Gray whales (82) taken here ranged from 30 to 42 feet in length.

WINTER RANGE

From early January to the end of February, the California gray whale population is concentrated in the coastal area from about San Diego southeast to Cabo San Lucas and the southern end of the Gulf of California. For convenience, the winter range may be divided into (1) migrating and wandering areas which are utilized by nonbreeding whales and by whales en route to more southern parts of the winter range, and (2) calving areas, utilized by whales for mating and calving (fig. 4).

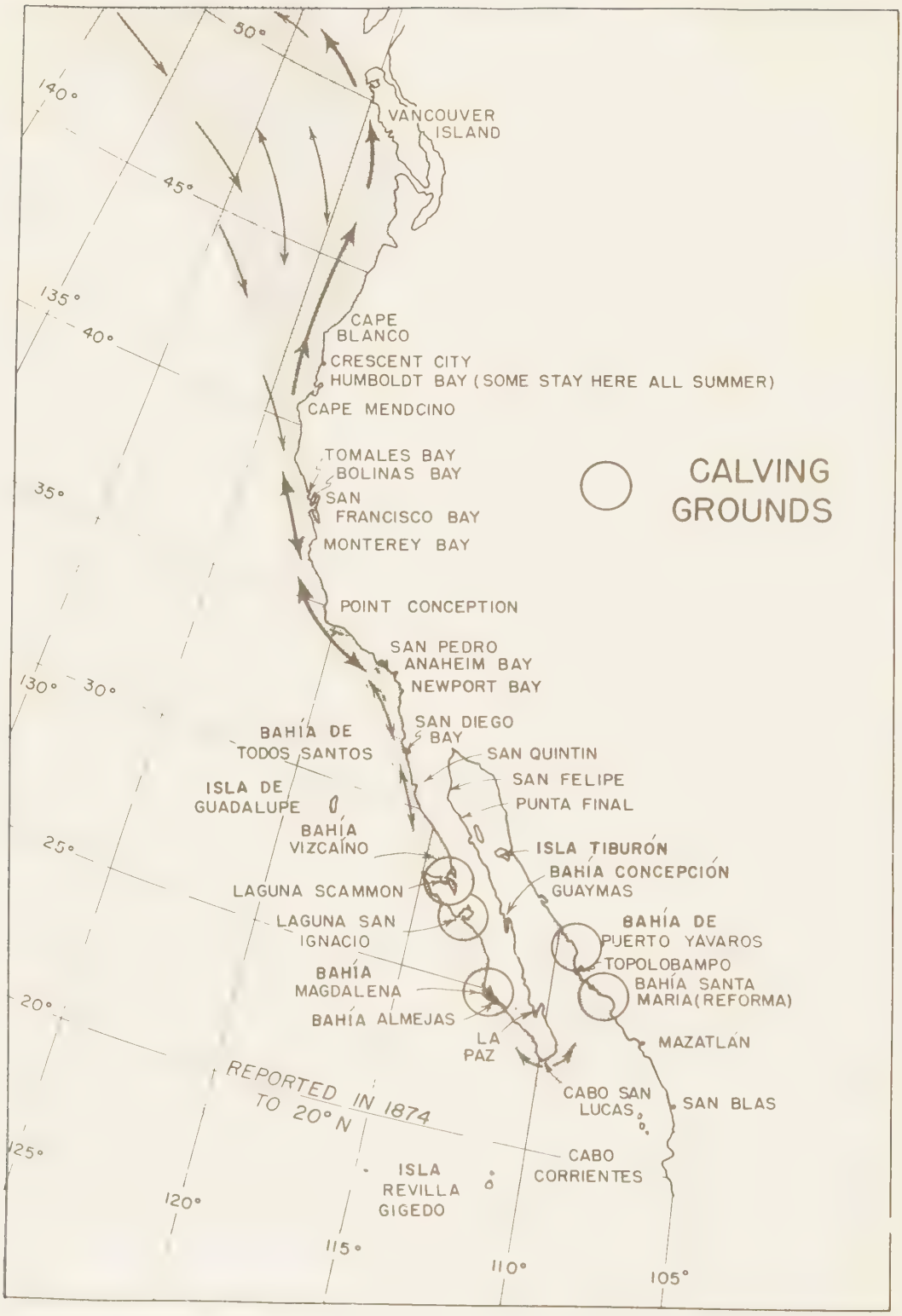

Figure 2.--Migratory routes of the gray whale (southern part).

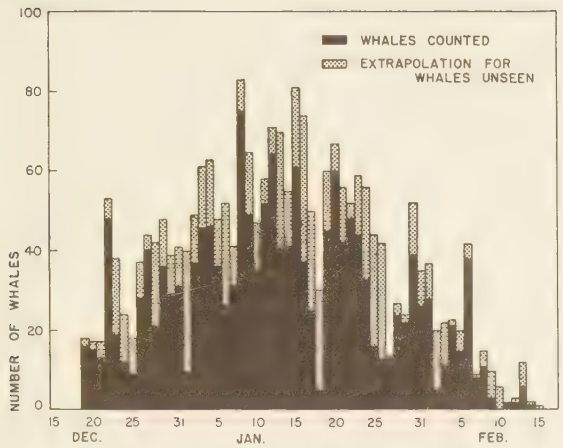

Figure 3.--Daily counts and extrapolations of gray whales passing San Diego during the southward migration, 1954-55.

Areas of Migrating and Wandering

For census purposes, areas of migrating and wandering have been broken down as follows:

Northern area.--The northern area extends for 350 miles from San Diego along the west coast of northern Baja California to Punta Santo Domingo, at the northeast periphery of the huge, open Bahia de Sebastian Vizcaíno (fig. 5).

Vizcaíno area.--The Vizcaíno area extends from Punta Malarrimo on the south shore of Bahía de Sebastián Vizcaino, not far from Laguna Scammon, west and then south around the Peninsula de Vizcaíno to Punta Abreojos at the northern end of Bahía Ballenas, near Laguna San Ignacio. A few gray whales were seen at Isla de Cedros and the Benitos, 30 miles northwest. Bahía San Bartolomé was never seen occupied by gray whales during the period of the censuses (fig. 6).

San Juanico area.--A 75-mile stretch of low, sandy coast extends from Boca Querante to Boca Las Animas, and includes the important open bay, or bight, of San Juanico. No whales were seen within the small, but apparently deep Laguna San Gregorio at any time during the censuses. Cows and calves were seen in Bahía San Juanico and it was possible that the calves were born there, although the area was not considered a true calving ground (fig. 7).

Cabo San Lucas area.--The large Cabo San Lucas area comprises the entire coastline of the "Cape Area" of the Peninsula of Baja California, from Boca Santa Marina to near La Paz, around Cabo San Lucas. Before the discovery of calving grounds in the Gulf in February 1954, whales seen in this area were thought to be nonbreeding wanderers, but it is realized now that the gray whales seen in the Cape area were, at least in part, migrants to and from the Gulf (fig. 8).

Extralimital areas.--Gray whales were observed a number of times in winter outside their normal range, in the Gulf of California and near offshore islands in the Pacific.

In the Gulf, north of the regularly used La Paz and Yávaros areas, 10 gray whales have been seen (1) four adults at Canal San Lorenzo near La Paz; (2) a cow and calf at Bahía Concepción, 250 miles north on the east side of the Gulf; (3) two adults, slightly north of Santa Rosalia; (4) one adult, 100 miles north of Santa Rosalia; and (5) one adult at Punta Final, 500 miles north of Cabo San Lucas, on the east side of the Gulf.

In the Pacific, gray whales have been seen at Isla Guadalupe, 125 miles off northern Baja California, and at Isla Clarión, the westernmost island of the Revilla Gigedo group, 375 miles southwest of Cabo San Lucas. One whale was seen within 100 yards of the beach of the northeast bay on Isla Guadalupe, on February 15, 1957, by Arthur Flechsig, zoologist from Scripps Institution of Oceanography. On March 13, 1957, Daniel Brown, also from Scripps, saw 15 gray whales, 4 of which were calves, at the southwest end of Isla Clarión.

Calving Areas

The female California gray whale normally resorts to lagoons, bays,

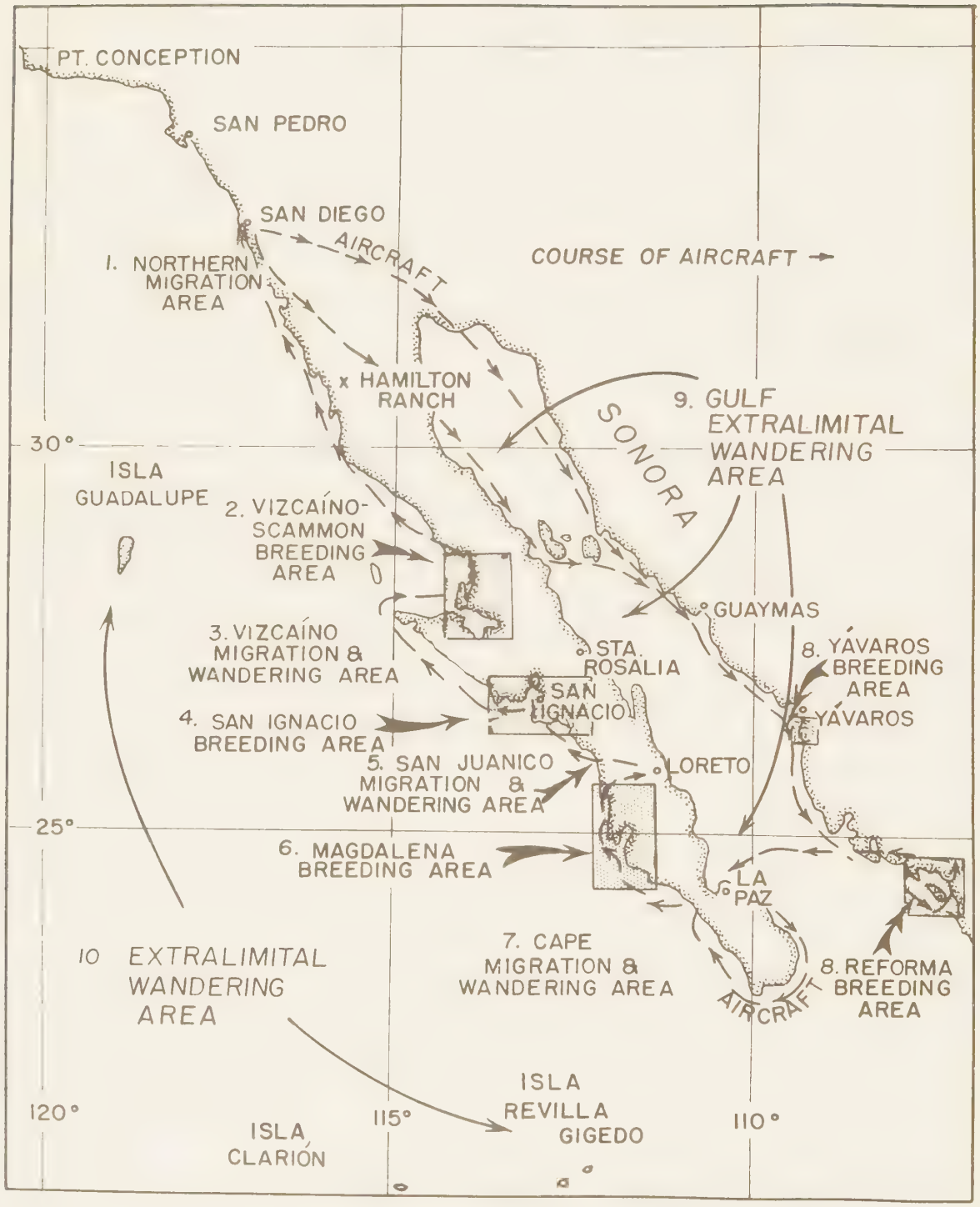

Figure 4.--Gray whale winter grounds.

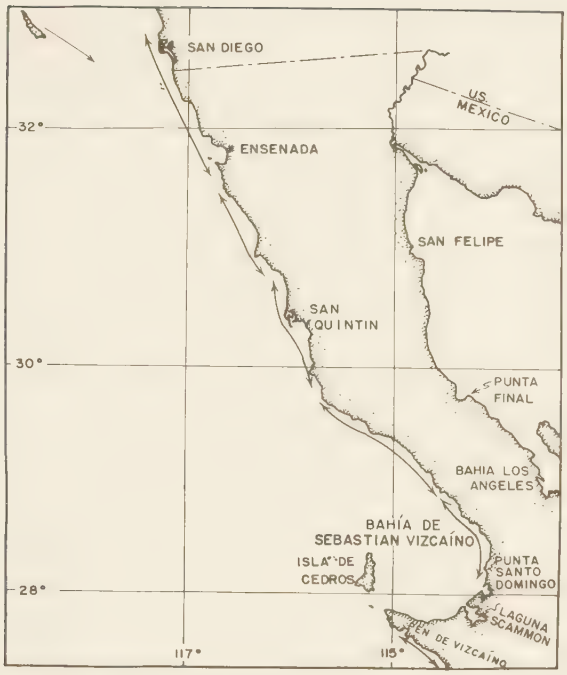

Figure 5.--Northern area of migrating and wandering.

Figure 6.--Vizcaíno area of migrating and wandering.

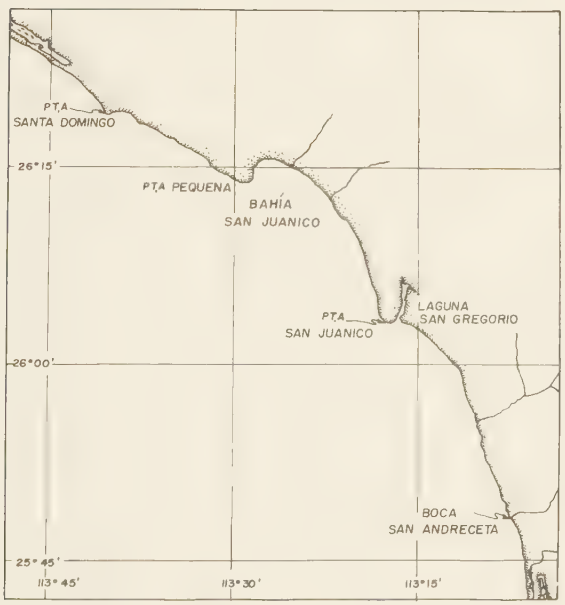

Figure 7.--San Juanico area of migrating and wandering.

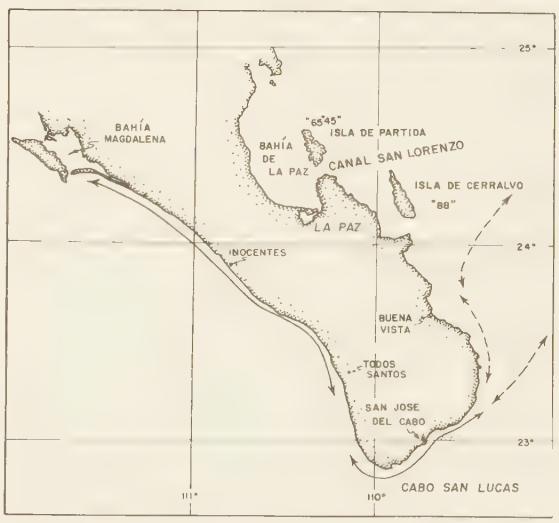

Figure 8.--Cabo San Lucas area of migrating and wandering.

and esteros[1] to bear her calf. Occasionally, calves are born in shallow, open water close to shore. Calving occurs, or formerly occurred, in six general areas: (1) San Diego (abandoned), (2) Vizcaíno-Scammon, (3) San Ignacio, (4) Magdalena, along the Pacific Coast of southern California and Baja California, (5) Yávaros, and (6) Reforma, along the east shore of the Gulf of California in the states of Sonora and Sinaloa (figs. 2 and 4).

San Diego area.--Gray whales used to breed in large numbers in San Diego Bay, but these were largely exterminated by two whaling stations at the entrance in the 1850's, 1860's, and 1870's. Subsequently, boat traffic, water pollution, and harbor improvements have effectively prevented reoccupation. However, gray whales occasionally calve, and more often mate, in open waters just outside the bay. A lobster fisherman, visiting his pots in kelp beds south of La Jolla in January 1955, saw "many times" a gray whale cow and calf. This account was recorded by Carr Tuthill of the aquarium of Scripps Institution of Oceanography. During the 1955-56 season, two calves were born in waters off the San Diego area (fig. 9).

Two bays in northern Baja California, Bahía de Todos Santos (including Estero de Punta Banda) near Ensenada, and Bahía San Quintin, near San Quintin, also appear to be suitable as calving areas for gray whales. No whales were seen in either bay. Gray whales surely inhabited both areas, although no historical evidence to this effect has been uncovered (fig. 5).

Vizcaíno-Scammon area.--The Vizcaíno-Scammon area includes (1) the shoreline of Bahia Vizcaíno from Punta Santo Domingo to Punta Malarrimo, (2) Laguna Guerrero Negro, and

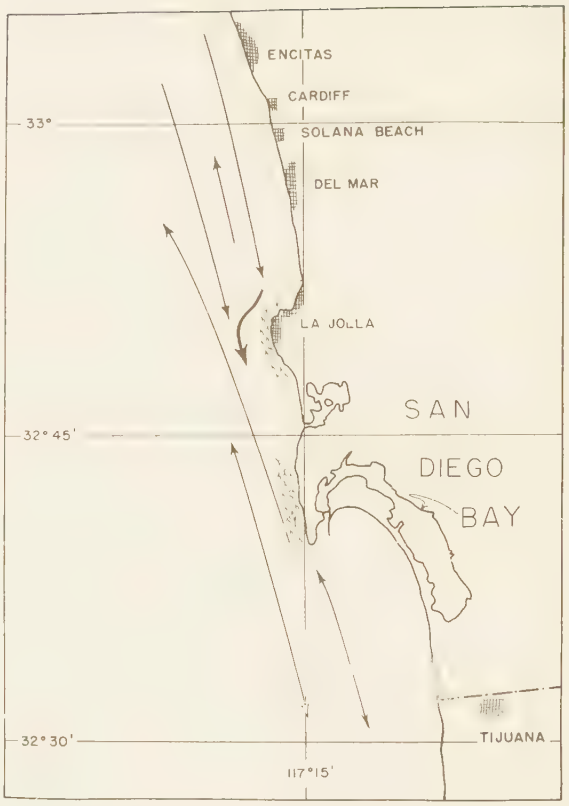

Figure 9.--Former San Diego calving area.

(3) Laguna Scammon. It includes about 30 miles of coastline and bars, and 100 to 200 square miles of channels navigable by gray whales, in Laguna Guerrero Negro and Laguna Scammon. Laguna Manuela was not occupied by gray whales during the period of the censuses (fig. 10).

San Ignacio area.--Included in the San Ignacio area are (1) the open bight of Bahía Ballenas; (2) the large and important Laguna San Ignacio; and (3) the small, as yet unnamed, lagoon farther south, called here "Laguna Querante" (from a nearby ranch so marked on the U. S. Navy hydrographic chart 1493, based on surveys made in 1890-95). Perhaps 30 to 50 square miles of lagoon channels are navigable to the gray whale in San Ignacio and Querante. Gray whales were never seen in Laguna Coyote during the censuses (fig. 11).

Magdalena area.--A distinct calving and mating ground, the Magdalena area

[1] An *estero* is a long, narrow body of water parallel to the coast and separated from the sea by a barrier beach. A channel between an estero and the sea is a *boca*. A lagoon *(laguna)*, as the term is used here, is a large body of water which extends several miles inland and is partially cut off from the sea by a bar across its mouth. A bay *(bahía)* is a marked indentation of the coastline not usually separated from the sea.

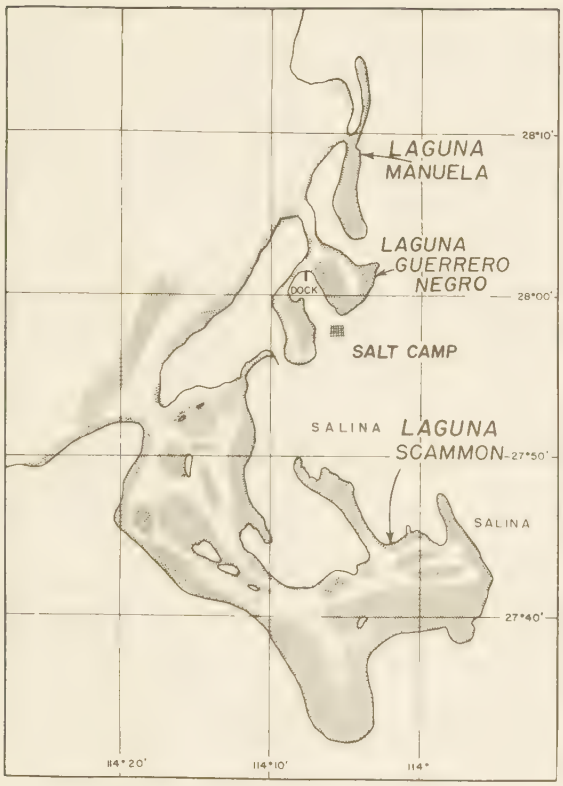

Figure 10.--Vizcaíno-Scammon calving area.

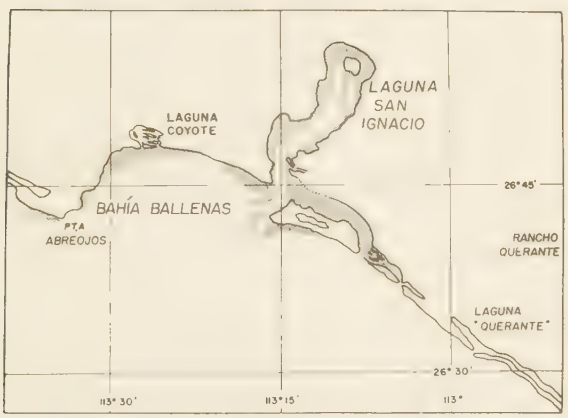

Figure 11.--San Ignacio calving area.

includes (1) the long esteros (Las Animas, Santo Domingo, and Soledad) north of Bahía Magdalena, parallel to the ocean beach but separated from the ocean by a continuous sand barrier with three bocas, (2) the upper reaches of the bay, such as Canal San Carlos, (3) the wide and deep Bahía Magdalena itself, and (4) Bahía Almejas, the south arm of Bahía Magdalena. This entire area includes 130 miles of low or rocky coast, and also some 200 to 250 square miles of esteros, lagoons, and bays accessible to the gray whale (figs. 12 and 13).

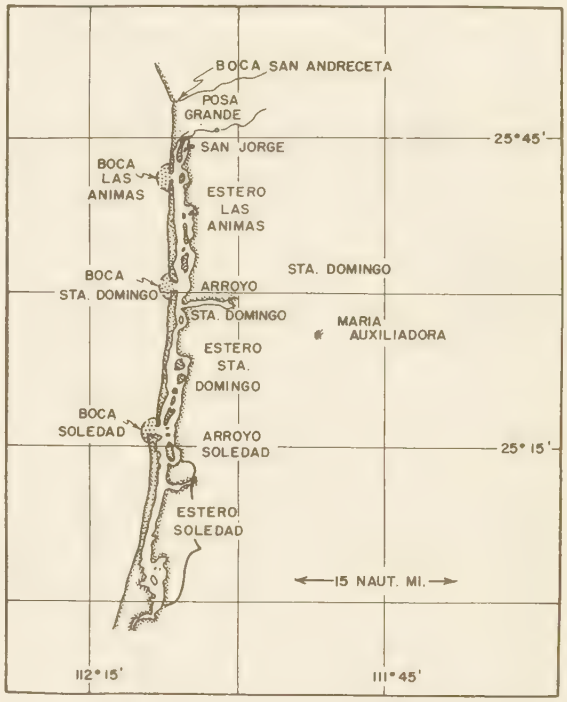

Figure 12.--Magdalena calving area (northern part).

Figure 13.--Magdalena calving area (southern part).

In the 19th century, the enormous and complex Magdalena area was probably the principal breeding ground of the California gray whale. However, because its central waters were accessible to sailing ships and its shallower tributaries to whaleboats, its whale population was soon exploited. From 1952 through 1957, boat traffic was often seen in the main bay. Gray whales consorted in numbers only in the more inaccessible tributaries.

Yávaros area.--In February 1953, an aerial survey of the Yávaros area disclosed breeding grounds at Yávaros and Bahía Reforma, on the eastern side of the Gulf of California. Whales had never before been found here, even by early whalers.

The Yávaros area is about 6 to 8 miles south of the port and bay of Yávaros, Sonora. It seems to have no distinctive feature which would attract gray whales. The water is only 2 to 5 fathoms deep. The whales observed were from 200 to 800 yards from the beach, leaving mud trails behind them as they swam in waters believed to be as shallow as 2 fathoms (fig. 14).

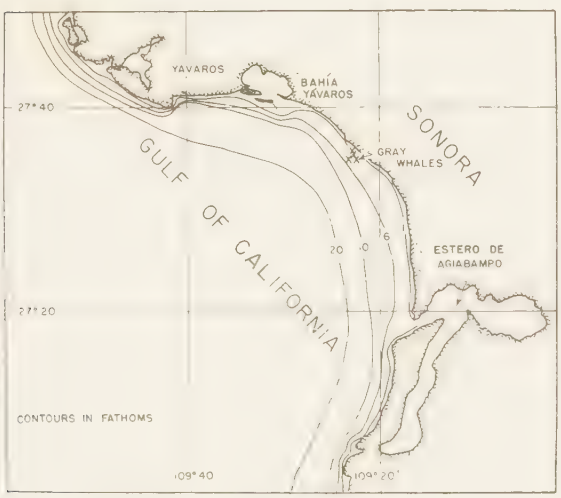

Figure 14.--Yávaros calving area.

Reforma area.--Bahía Reforma is a huge lagoon-like bay 120 nautical miles southeast of Yávaros, in the State of Sinaloa. It is about 35 miles long and is navigable by whales and small boats. There are perhaps 10 to 20 square miles of lagoon in the northern part well suited to gray whales (fig. 15).

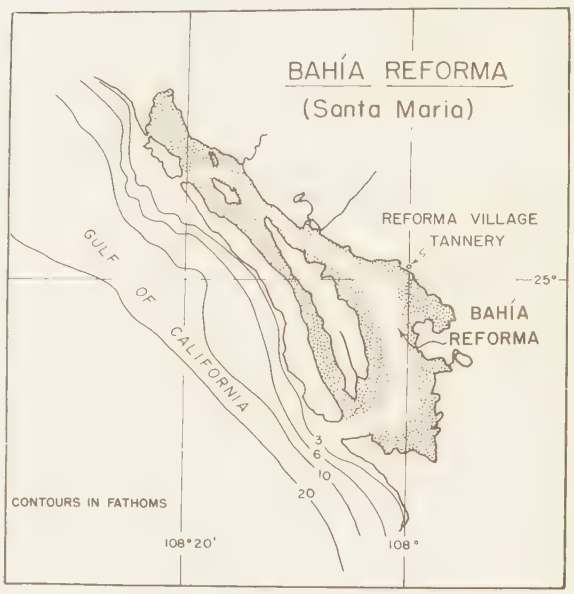

Figure 15.--Reforma calving area.

NORTHWARD MIGRATION

The northward migration first passes San Diego in mid-February, is in full swing in March and April, and tapers off in early May. Gray whales going north seem to veer off the coast at Point Loma, passing La Jolla several miles at sea, as though on direct course across the great bight of the coast of southern California from San Diego to Palos Verdes Peninsula. Because movement apparently is away from the coast, it does not seem possible to count the migration north with the same accuracy possible for the southward migration. From Palos Verdes Peninsula, most whales migrate parallel to the coast on their way north.

Vessels engaged in fur-seal research for the Bureau of Commercial Fisheries, in 1958 and 1959, sighted gray whales during March from 36°46'N. in Monterey Bay to 41°23'N. off Gold Bluffs, California. April observations ranged from 40°47'N. off the Eel River in California to 47°54'N. off James Island, Washington. On April

24, 1959, personnel on the vessel *Tacoma* saw more than 200 gray whales from about 19 miles off Destruction Island to near James Island. On that day they saw a bloated, dead gray whale rise to the surface. On April 25 the vessel ran out of the gray-whale concentration 9 miles off James Island (C. H. Fiscus, T. C. Juelson, and K. Niggol, in lit.). Observers on the Canadian research vessel *Pacific Ocean* saw gray whales off Cape Flattery, Washington during the last 2 weeks in May (Gordon C. Pike, in lit.).

Annually, large numbers of whales concentrate close to the west shore of Vancouver Island in March and April, many passing through the mile-wide channel between Solander Island and Cape Cook on the northern part of Vancouver Island. After passing along the west coast of Vancouver Island, the whales disappear in a westerly direction into the North Pacific Ocean. As late as May 17, 1959, gray whales were observed off the north end of Vancouver Island by whalers from the station at Coal Harbour, Quatsino Sound.

Nine gray whales were taken for scientific purposes in April 1952 from the station at Coal Harbour under special permit issued in accordance with the provisions of the International Convention for the Regulation of Whaling. Northward migrating whales were too thin to be of commercial value.

Eight gray whales, in pairs, were seen on May 11, 1957, moving very close to the kelp between Kodiak and Ugak Islands toward Narrow Cape, Alaska (F. Wilke, in lit.).

BEHAVIOR STUDIES

BEHAVIOR DURING MIGRATION

Actions which will enable them to arrive quickly at the breeding grounds seem completely to dominate the behavior of gray whales as they swim past San Diego. They do not wander or feed. Occasionally, whales stop and attempt to court or mate, but even these rarely stay long or wander from the migration route.

Orientation to Land

Close adherence to the coasts of southern California and Baja California is an outstanding feature of their migratory behavior. The herd passes along the coast, skirting headlands and sometimes cutting across bays, generally remaining within three miles from shore. Such behavior must help them find the entrance of shallow bays and lagoons for calving and mating.

A gray whale will often thrust its head completely out of the water, almost to the flippers, and hold it out for about 10 seconds. Or when "blowing" at the surface, the whale will merely raise its head out as far as the eyes. Subsequently, the whale's movements will suggest reorientation based on visual stimuli. Gray whales sometimes follow the walls of deep submarine canyons in La Jolla Bay instead of the shoreline. This suggests that they may be following, in preference to the coast, a bottom contour of 100 to 150 feet depth.

The extent to which vision may aid navigation along the shore, nor the extent to which darkness may slow travel, could not be measured. Fog is believed by some observers to slow travel but this has not been proved.

Daily Cycle of Observations

During a count in 1954-55 from Point Loma, sightings of 1,319 whales were recorded by hour of day. For each consecutive hour between 7 a. m. and 5 p. m., the following number of sightings was recorded: 50, 145, 113, 103, 134, 99 (noon to 1 p. m.), 156, 189, 175, 155. The higher figures of afternoon are probably the result of

improved visibility--lifting of haze. The low values at 7 a. m. and noon may (?) represent human errors of some kind.

Increased visibility in late afternoon was demonstrated again in 1956-57, when the count of whales at La Jolla-Scripps from 3 p. m. to 5 p. m. equalled *29 percent* of the count at Point Loma from 7 a. m. to 5 p. m. (2 hours against 10). Had whales been observed at the same rate for the 2 hours as for 10 hours, the proportion would have been one-fifth or *20 percent*.

Social Behavior

Gray whales, like most large whales, travel singly or in small groups. The frequency distribution of groups in the 1952-53, 1954-55, and 1956-57 seasons is given in table 1. Single animals predominate in November and December. These are mostly large individuals, presumably pregnant females, traveling alone to the lagoons and bays to calve, and presumably not physiologically ready to mate. Most single animals, traveling later, are thought to be adult males, nonbreeding females, or yearlings. Little is known about differences in migratory behavior according to age and sex.

Groups of two and three are commonest in January. At that time, the animals are mating or courting en route. Groups of three would perhaps most logically be composed of two males and one female. (See section, below, on behavior on the winter range.) Groups of four perhaps include three males and one female, or two pairs joined by coincidence. Pregnant females are probably solitary, as are the yearlings not yet integrated into social groupings.

BEHAVIOR ON THE WINTER RANGE

Some observations of behavior were made during the aerial census, when animals were seen on the breeding and calving grounds and wandering nearby. Most behavior studies, however, were made at close range from small boats propelled among the whales during special visits to the breeding lagoons.

Behavior studies on the winter range were made at Estero Las Animas on February 22, 1953, and at Laguna Scammon on February 17-25, 1954, February 4-14, 1955, January 25 to February 8, 1956, and February 9-18, 1957.

In and near the breeding lagoons, gray whales appear to be segregated by age, sex, and reproductive condition.

Outer and Intermediate Area

Most whales seen outside the entrances of lagoons are evidently idle adults, courting adults, or immatures. No calves and no recently parturient females are found here.

The intermediate area consists of channels within the entrance. Many nuptial groups, some cows and their newborn calves, and some wandering singles are found in these locations. Mating and courting is done between adults without calves present. Pairs of courting adults are the commonest reproductive group, but groups of three are also common. On one occasion, three adults were identified by copulatory activity as a female, a dominant male, and probably a complemental male. The sex of the latter was not definitely ascertained, but its nervous, "sideline" participation suggested that it was a male. (If only half the females breed each year, as the author suspects, and if the sex ratio is 50 : 50, there will be twice as many eligible males as females on the breeding grounds.) Breeding pairs and trios are most common near the outer entrance of the lagoon but also penetrate the lagoon to its very head, and are observed outside the lagoon. Segregation of courting groups and cows with calves is more distinct in the Magdalena area than in the Scammon area.

TABLE 1.--FREQUENCY DISTRIBUTION OF GROUP SIZE OF GRAY WHALES DURING THE SOUTHWARD MIGRATION PAST SAN DIEGO

Number of whales in group	November 2-December 31			January 1-January 15			January 16-January 31			February 1-February 13			Season total		
	No. of groups	No. of whales	Percent whales	No. of groups	No. of whales	Percent whales	No. of groups	No. of whales	Percent whales	No. of groups	No. of whales	Percent whales	No. of groups	No. of whales	Percent whales
1	250	250	34	256	256	18	226	226	20	62	62	24	794	794	22
2	132	264	35	260	520	37	255	510	45	67	134	51	714	1,428	40
3	61	183	24	92	276	20	81	243	21	14	42	16	248	744	21
4	12	48	6	31	124	9	21	84	7	6	24	9	70	280	8
5	2	10	1	20	100	7	8	40	4	-	-	-	30	150	4
6	-	-	-	9	54	4	4	24	2	-	-	-	13	78	2
7	-	-	-	4	28	2	1	7	1	-	-	-	5	35	1
8	-	-	-	4	32	2	-	-	-	-	-	-	4	32	1
12	-	-	-	1	12	1	-	-	-	-	-	-	1	12	1
Total		755	100		1,402	100		1,134	100		262	100		3,553	100

In the Magdalena area, courting groups are confined mainly to the outer waters, and cows with calves to inner waters.

Inner Nursery Area

Most cows with calves retreat far into the lagoon, although some occupy the area in and around the entrance. Cows and their calves gather in great numbers in Laguna Scammon, 20 to 30 miles from the entrance. Some courting pairs and a few trios may also be seen here in the upper end. A cow and her calf are rarely seen with other whales. No cow with calf was seen engaged in mating, although on two occasions a cow with calf was seen swimming in company with another adult.

The count of whales during a traverse of the three areas in Laguna Scammon on January 25 and 26, 1956, gives a quantitative idea of the distribution of the groups. A total for the entire 15-day trip would be misleading because the length of time spent in the three areas differed (table 2).

TABLE 2.--FREQUENCY DISTRIBUTION OF GROUP SIZE OF GRAY WHALES ON BREEDING GROUNDS

Composition of group	Frequency		
	Outside bar and channel	Intermediate area	Inner nursery area
Single adult.....	19	20	8
Two adults.....	3+	10+	4
Three adults.....	1+	6	3
Cow with calf.....	-	12	30
Cow-calf-adult.....	1 (coast)	-	-
Four or more.....	-	-	-

REPRODUCTION AND MORTALITY

REPRODUCTION

Pregnant female gray whales taken by the *Vega* (Risting, 1928) ranged from 34 to 50 feet in length; mean length of 23 such females was 37.3 feet. The maximum of 50 feet is 5 feet longer than given in other records. Cows with newborn calves do not engage in courtship activity. Evidently, therefore, recently parturient cows are not in estrus, and likely do not come into estrus until the following winter, after the calf has been weaned. Reproduction may thus be biennial. If so, it would follow that some females each year bear young and nurse while the others mate. Since copulation and parturition are observed at the same time of year, the gestation period must be 11 to 12 months. Two females killed on March 13 and 14, 1912, at Chan Chien Dogo, Korea, each contained a fetus, one 7 and one 10 inches long. Nearly grown fetuses found in females at Magdalena Bay were reported by Risting (1928) as 16 to 17 feet long. These fetuses seem improbably long. The observed number of new offspring with an adult was always one.

MORTALITY

Mortality is thought to be high in the newborn class but not in any other

age group. Twelve dead calves were found in Laguna Scammon: 5 in 1954, 2 in 1956, and 5 in 1957. Measurements of seven are as follows (length in feet): 11.6, 12.0, 12.5, 13.4, 13.9, 14.7, 14.8; mean 13.25 feet. The sex of only two carcasses was identified, a male 12.0 feet and a male 14.7 feet. The causes of death among calves are not known. Presumably, as in other mammals, congenital defects, failure of the female to provide adequate milk, and accidents cause some mortality among the newborn.

During four seasons of study in Laguna Scammon, only two dead adults were found; both were stranded.

HISTORY OF THE CALIFORNIA GRAY WHALE POPULATION, 1850-1952

Annually, from the 1850's to the 1890's, the California gray whale was captured systematically in winter along the coast of California and Baja California from shore stations and from whaling ships. Ships entered the lagoons and harassed the cows with calves, as well as the breeding adults. Unrestricted whaling on the breeding grounds reduced the herd from a high of perhaps 25,000 to 50,000 to a low of a few thousand animals (Gilmore, 1955).

Andrews (1914), as well as Howell and Huey (1930), and Zenkovich (1934), considered the gray whale headed for extinction. The small, residual California herd at the turn of the century escaped detection by zoologists because no serious effort was made to look for them.

From the 1890's to the early 1920's, gray whales off California were relatively unmolested. Shore operations from Monterey and San Pedro were small. A Norwegian factory ship hunted for a time off Baja California. The California herd was actually increasing, though at a rate unknown. A. W. Anthony (1921) reported that gray whales were "common" off San Diego.

From 1924 through 1937, the California gray whale was hunted in southern California and Baja California during winter, and off northern Kamchatka and in the Chukchi Sea during summer. Throughout this period, the gray whale was thought to be scarce, numbering perhaps a few hundred individuals. From 1935 to 1938, Karl W. Kenyon (in lit.) frequently observed gray whales off southern California and did not consider the species scarce in that area.

In 1936 (to take effect in 1937) the United States Government prohibited the capture of gray whales by Americans in American waters. In 1937 (to take effect in 1938) the International Convention for the Regulation of Whaling, signed in London, gave the gray whale complete protection over its entire range.

In August 1940, before Japan became a party to the Convention, Japanese nationals took 58 gray whales in Chukchi Sea and Bering Strait from the floating factory *Tonan Maru* (original records). Since 1947, unrecorded numbers, though certainly few, have been captured by aborigines of the U.S.S.R. off northern Kamchatka and the Chukotsk Peninsula.

From 1946-47 to 1951-52, Dr. Carl L. Hubbs estimated the numbers of gray whales migrating southward past La Jolla by instituting a "whale-watch" atop a classroom building at Scripps Institution of Oceanography. The whale-watch was maintained by volunteers about 15 minutes out of each daylight hour. The total estimated daylight migrations for the first six years are as follows (unpublished notes by courtesy of Dr. Hubbs):

1946-47	250 whales
1947-48	500 "
1948-49	600 "
1949-50	600 "
1950-51	no estimate
1951-52	880 whales

In December 1952, the Fish and Wildlife Service began a study of the California gray whale population. It continued until the end of the 1956-57 season. (See objectives, page 3).

SHORE CENSUS OF THE SOUTHWARD MIGRATION, 1952-53 to 1956-57

METHODS

Areas

A satisfactory count of whales migrating south can be made from three points of vantage at San Diego. Two were used routinely by the writer. The first is the summit of Point Loma, a ridge of land separating curved San Diego Bay from the sea at its northwest side. The southern end of Point Loma faces southeast over the entrance to the bay and over the entire length of coast extending south to Mexico, 15 miles away. It also faces the Pacific Ocean to the southwest, west, and northwest, and the coastline to La Jolla, 10 miles to the north. The panoramic view over the Pacific is about 200 degrees. The elevation is 510 feet above sea level, which allows an observer to see about 15 miles to the horizon. Water of 300-foot depth lies 4 to 4-1/2 miles offshore. Kelp beds, marking approximately the 100-foot depth contour, are less than 1-1/2 miles out. Thus, whales can skirt the point closely and can be observed easily.

Counts were conducted from a military bunker partly buried in the summit of the western cliff on Point Loma. The bunker gave shelter from the elements, as well as a place to sit and write, and it offered good visual sweep of the Pacific Ocean. From this location, two seasonal assistants carried on a count of gray whales migrating south. Point Loma ridge is the site of Cabrillo National Monument, and one of the most popular attractions here in winter is the whale migration. During the study, the National Park Service maintained a "public whale-watch" with the aid of the Superintendent Donald Robinson and Ranger-Naturalists Theodore Walker and Robert Grom. Many tourists looking for whales joined the watch daily and their presence helped to alert the regular watchers to "spouts."

The second point of vantage, used by the writer, was atop a classroom building at Scripps Institution of Oceanography in La Jolla, 12 miles north of Point Loma. This lookout post was protected from the weather by a small, wooden structure, and housed a pair of 18-power binoculars on a stand. The slight curvature of the coast and the westward prolongation of nearby Point La Jolla for one mile, to form the bay of La Jolla, put this observation post at a greater distance from the center of the path of migrating gray whales than Point Loma or Point La Jolla. The low elevation of the Scripps lookout, which is about 100 feet above sea level, obliges the watcher to look through more haze and to scan the sea at a lower angle, making whale "slicks" more difficult to see.

The fact that the location at Scripps is two hours or slightly more, "as the gray whale swims," from Point Loma, allows addition to the Point Loma count of the numbers of whales that pass Scripps from 3 p. m. to 5 p. m. Part of these whales do not arrive at Point Loma until after dark. The hours of whale watching at Point Loma are thus increased, in effect, by two, from 10 hours to 12.

The third point of vantage in the San Diego area is Point La Jolla itself. From here, either from the crest of the sea-cliff some 25 feet above high-tide mark, or from any road parapet nearby, gray whales may be easily seen as they pass along the outer edge of the kelp beds just off the point. The kelp beds, which grow on the rocky bottom, extend to the 100-foot depth contour not more than 800 yards from shore.

Gray whales come closer to land at Point La Jolla than at either of the other posts, and permit the clearest and most exciting views of the animals. However, lack of shelter limits the use of this point as a whale-counting station.

Procedure

Whale counters were usually stationed at Point Loma, where each counted for five hours daily, either from 7 a. m. to noon, or from noon to 5 p. m. These periods cover the 10 daylight hours of midwinter at the latitude of San Diego, 32°45'N. Five hours are about the limit of endurance of one counter; a longer period produces observational fatigue.

Each counter was equipped with a logbook, a pair of binoculars, and a watch. Each time a whale, or group of whales was sighted, the time, number of whales, and visibility were recorded.

Identifying characters of the gray whales, of use to the watchers, are the length of 30 to 45 feet, color dark gray or nearly black, blotched with white marks of roughly circular or irregular outline up to a foot in diameter, absence of dorsal fin which is replaced by a low, thick ridge followed by a series of 8 to 12 small sharp knuckles and a convex rostrum. The dorsal ridge and series of knuckles are the most characteristic and easily observed diagnostic feature of the gray whale. The flukes are often thrown conspicuously in the air on a "sounding" dive. Although of characteristic shape with small tips and prominent rear curve, the smallish flukes are not always seen clearly.

Extrapolations

In virtually all wildlife censuses, some individuals escape detection and are not counted. In estimating the whale population, the writer has added corrections for whales which passed (1) during bad weather in daytime with poor or no visibility, (2) at night, and (3) beyond sight of land.

Extrapolations for poor visibility.--Daytime bad-weather extrapolation was based on three points: (1) degree of visibility; (2) abundance of whales, i. e., intensity of migration at the time; and (3) density of fog (when reduced visibility was caused by fog) because fog was assumed to slow the rate of travel.

When visibility was not zero, and some whales were seen close to shore, extrapolation was based directly and entirely upon the estimated degree of reduced visibility. For example, if the haze settled so heavily that visibility was lowered to 1,000 yards, or 25 percent of normal, and 10 whales were seen, the number estimated to have passed unseen was 30, or a total of 40.

When rain or fog reduced visibility to zero, the nearest period of clear visibility was taken as a basis for extrapolation. For example, if visibility was completely blanked out by fog in morning (7 a. m. to noon) and the afternoon hours (noon to 5 p. m.) were clear, and 25 whales were seen, the extrapolation value for the morning was 25. Or, if there had been three days of heavy fog with visibility zero, the past previous day of good visibility was taken as a basis for extrapolation. If 50 whales had been seen on that day, the extrapolated value for each of the three foggy days would be 50.

Persistent foggy weather was believed to slow down travel of whales. If three foggy days occurred in a row, the extrapolation was weighted downward by 40 percent; the extrapolation was further reduced if the fog continued. (Here the writer freely admits the possibility of fairly serious error.)

Extrapolation for night migration.--Gray whales are known to migrate at night. They are seen occasionally from boats, though the speed of night travel has never been learned. Nevertheless, suppositions which lead the writer to conclude that gray whales slow down considerably at night are as follows:

> Whales presumably have occasional rest periods. As whales were not seen sleeping in daytime, they must do so, if at all, at night.
>
> If dependence is upon vision (in air) for close navigation of the shore, and light of sun or moon is

required, then dark nights could slow migration greatly.

Whales may have some irregular feeding activities, particularly nocturnal, but no whales migrating in the day were seen feeding off southern California.

The distance from northwestern Bering Sea to San Diego is about 6,000 miles. If a little less than three months is postulated as a reasonable time for swimming this distance, and four knots is an average swimming speed, then a gray whale could sleep seven hours in each 24-hour period.

On the basis of these suppositions, and lacking accurate information, 50 percent of daytime movement was used as an extrapolation for night movement.

In making extrapolation for night migration, two methods of dividing the day into hours of daylight and darkness are evident. The time of sunrise and sunset from late December to mid-February at La Jolla divide the day into 10 to 10-1/2 hours of daylight and 13-1/2 to 14 hours of darkness. If the 7 a. m. to 5 p. m. Point Loma count and the 3 to 5 p. m. Scripps count are added together, the day consists of 12 hours of daylight and 12 hours of darkness. A count made on this basis would be 5 to 6 percent greater than if the sunrise-to-sunset division of the day is used because of the lesser movement assumed for night. Compared with other unavoidable inaccuracies in the whale count, this difference is unimportant. For the sake of simplicity, the 50-percent reduction in migratory rate for two hours each day is ignored.

Extrapolation for offshore migration.--As an arbitrary correction for whales traveling offshore, the writer added 5 percent of the total number estimated to have passed San Diego within sight of land.

RESULTS

Census of 1952-53

In general, the weather was good in 1952-53 and counts were high. During this first year, the census method was experimental, although the writer had profited from the experience of Dr. Hubbs. Whales were counted intermittently at La Jolla from December 3-15 and, except for five days, an intensive watch was maintained from December 15 through February 15. At Point Loma, the public whale-watch was intensive only on weekends, December 26 through February 15, and then continued intermittently from February 16 through March 13.

On this schedule, both crews counted whales (mostly the same individuals) from December 26 through February 15. The higher daily count, regardless of locality, was recorded as the value for that day.

The La Jolla-Scripps post could not be manned for 10 continuous hours every day, even with the help of volunteers.

The Point Loma post of the Cabrillo National Monument was never manned during the public whale-watch from 7 a. m. to 9 a. m., and often not until 10 a. m. On week days, it sometimes was not manned at all because of other time demands upon the small, regular staff. Consequently, a 20-percent adjustment was made in the daily count for the 2 hours out of 10 when whales were not counted. Even when the La Jolla-Scripps count was nearly perfect in coverage and visibility, and exceeded the count at Point Loma, the 20-percent extrapolation was necessary because the count from 7 a. m. to 9 a. m. at Point Loma represented whales which had passed La Jolla during the night or early morning and could not have been seen there.

Census of 1953-54

At Point Loma, the National Park Service kept watch for southbound whales when an observer was available and when the part-time watcher

of the Fish and Wildlife Service was off duty. Shortage of manpower and bad weather gave unsatisfactory results. The census could not be analyzed with confidence.

Census of 1954-55

The 1954-55 census was a success. Good weather prevailed and one of the two whale counters employed showed special adeptness in his work. For the first time, the whale-watching post at Point Loma was manned throughout the season by two Fish and Wildlife Service employees. They were continually on duty from 7 a. m. to 5 p. m., or during the entire 10 hours of daylight.

The post at Scripps Institution of Oceanography was also manned for the first time continually from 3 p. m. to 5 p. m.

Census of 1955-56

Because the census of 1955-56 was incomplete, its results cannot be compared with those of other seasons.

In addition to the posts at Point Loma and La Jolla, an additional whale-watching post was established at Del Mar, five miles north of La Jolla, for the education of Boy Scouts under the supervision of Donald Lear, then a graduate student at Scripps Institution of Oceanography, La Jolla. The hours of watching were from 4 p. m. to 5 p. m., or slightly later as daylight and visibility conditions permitted. The Del Mar data are not utilized in the present publication.

The count for this season was low, partly because of poor visibility and partly because the main herd arrived late and straggling. Severe storms on the North Pacific in early December 1955 (see Danielsen and others, 1957) may have disrupted the migration and caused the whales not only to arrive late in southern waters but to arrive in clumps. Great gaps appeared in the line of migration; several concentrations of unusual size were seen near San Diego.

Census of 1956-57

The season of 1956-57 was the most successful of the five. The weather remained fairly good. The count, as anticipated on the basis of previous observations by Hubbs and the writer, proved to be the highest thus far obtained.

Counting of southward migrants at Point Loma by the Fish and Wildlife Service covered 10 hours each day during the main migration. The National Park Service helped before and after the regular season and on weekends. The supplementary watch at Scripps Institution of Oceanography was active from 3 p. m. to 5 p. m. or a little later.

Table 3, giving the count of gray whales during daylight hours, from November 2, 1956, to March 25, 1957, at Point Loma and La Jolla, is included in order to show the rise and fall of the migration.

SUMMARY OF SHORE CENSUSES

Three of five annual counts of southbound whales were conducted under favorable weather conditions and were nearly complete. These, fortunately, were on alternate seasons: 1952-53, 1954-55, and 1956-57. The other two counts (1953-54 and 1955-56), made under unfavorable weather conditions, were incomplete. Data from the three successful censuses indicate a steady upward trend in the population. In 1952-53, 1954-55, and 1956-57, the estimated populations passing San Diego were, respectively, 2,894, 3,603, and 4,454 (table 4). These figures represent an increase in the estimates of about 24 percent in each of the 2-year periods. Such increases seem too large for the population as a whole when it is considered that: (1) the population is probably 50 percent males, (2) females are believed to bear young only once in two years, (3) all females are not of breeding age, and (4) some mortality among both young and adults has been observed.

TABLE 3.--COUNTS AND EXTRAPOLATIONS OF GRAY WHALES PASSING SAN DIEGO, CALIFORNIA, DURING DAYLIGHT HOURS, 1956-57

Date	Point Loma 7 a. m. - 5 p. m.	La Jolla-Scripps 3 p. m. - 5 p. m.	Total daily count	Cumulative count	Percent visibility	Addition for whales not seen	Reduction for slow migration[1]	Daily total estimate	Cumulative estimate
1956									
2 Nov. to 15 Dec.	34		34	34		68		102	102
16 "	1	-	1	35	50	1		2	104
17 "	1	5	6	41	90	1		7	111
18 "	7	6	13	54	75	4		17	128
19 "	7	-	7	61	50	7		14	142
20 "	5	2	7	68	75	2		9	151
21 "	5	3	8	76	50	8		16	167
22 "	25	-	25	101	75	8		33	200
23 "	17	5	22	123	75	7		29	229
24 "	20	3	23	146	75	8		31	260
25 "	20	18	38	184	75	13		51	311
26 "	24	2	26	210	75	9		35	346
27 "	25	5	30	240	90	3		33	379
28 "	31	17	48	288	90	5		53	432
29 "	39	9	48	336	90	5		53	485
30 "	42	6	48	384	75	16		64	549
31 "	30	15	45	429	75	15		60	609
1957									
1 Jan.	42	14	56	485	75	19		75	684
2 "	48	3	51	536	75	17		68	752
3 "	33	[2] 2+11	46	582	50	35		81	833
4 "	30	4	34	616	50	34		68	901
5 "	33	24	57	673	75	19		76	977
6 "	50	13	63	736	75	21		84	1,061
7 "	7	2	9	745	-	75	-25	59	1,120
8 "	10	1+7	18	763	25	[3] 33	-15	36	1,156
9 "	20	3+15	38	801	50	23	-15	46	1,202
10 "	32	9	41	842	75	14		55	1,257
11 "	50	9	59	901	90	7		66	1,323
12 "	43	15	58	959	75	19		77	1,400
13 "	22	11	33	992	50	33		66	1,466
14 "	40	6+1	47	1,039	75	15		62	1,528
15 "	44	5	49	1,088	75	16		65	1,593
16 "	42	4	46	1,134	75	15		61	1,654
17 "	49	10	59	1,193	90	7		66	1,720
18 "	28	8	36	1,229	90	4		40	1,760
19 "	36	10	46	1,275	90	5		51	1,811
20 "	27	4	31	1,306	50	31		62	1,873
21 "	31	10	41	1,347	75	14		55	1,928
22 "	44	9	53	1,400	90	6		59	1,987
23 "	29	9	38	1,438	75	13		51	2,038
24 "	9	4	13	1,451	25	39	-10	42	2,080
25 "	32	18	50	1,501	75	17		67	2,147
26 "	10	6	16	1,517	25	48	-10	54	2,201
27 "	24	11	35	1,552	50	35	-10	60	2,261
28 "	20	10	30	1,582	50	30	-10	50	2,311
29 "	14	2	16	1,598	25	48	-15	49	2,360
30 "	35	6	41	1,639	90	5		46	2,406
31 "	8	8	16	1,655	75	5		21	2,427
1 Feb.	23	4	27	1,682	75	9		36	2,463
2 "	10	4	14	1,696	25	42	-10	46	2,509
3 "	9	1	10	1,706	75	3		13	2,522
4 "	10	1	11	1,717	50	11		22	2,544
5 "	4	-	4	1,721	50	4		8	2,552
6 "	4	1	5	1,726	25	15	-5	15	2,567
7 "	-	-	-	1,726	-	20	-10	10	2,577
8 "	-	-	-	1,726	-	20	-10	10	2,587
9 "	-	-	-	1,726	-	20	-10	10	2,597
10 "	-	-	-	1,726	25	10	-5	5	2,602
18 " to 25 Mar.	113		113	1,839	50	113		226	2,828
Total						1,149	-160		

[1] Number of whales deducted from estimate because of persistent bad weather; see page 21.
[2] Two whales seen at La Jolla-Scripps; 11 elsewhere. Extrapolation based on 35 whales only. Similar situations are indicated by plus-marks further down in this column.
[3] Seven whales were seen from boat in fog, but missed at Point Loma. Extrapolation as follows: (11/0.25) minus 15 = 36.

TABLE 4.--SUMMARY OF SHORE CENSUSES OF GRAY WHALES IN SOUTHWARD MIGRATION, 1952-53 TO 1956-57

	1952-53	1953-54	1954-55	1955-56	1956-57
Actual daily count.....	982	800	1,646	918	1,839
Daily extrapolation (bad weather).....	562	([1])	641	([1])	989
Estimate, all whales passing in day.....	[2] 1,837	([1])	2,287	([1])	2,828
Night extrapolation.....	919	([1])	1,144	([1])	1,414
Estimate, all whales passing San Diego.....	2,756	([1])	3,431	([1])	4,242
Plus 5 percent for offshore movement.....	138	([1])	172	([1])	212
Final estimate, size of California population.....	2,894	([1])	3,603	([1])	4,454

[1] No extrapolations because of incomplete data.
[2] Addition of 293 for 20 percent extrapolation for 2 hours not covered at Point Loma daily.

AERIAL SURVEYS OF THE WINTERING GROUNDS, 1952-1957

At one time, the writer believed that air-census methods could be standardized in time and procedure so that land censuses might be dispensed with, but his effort to accomplish this was unsuccessful. Large numbers of breeding whales shift from place to place in a short time, or from season to season, with the result that they cannot be found in exactly the same place from one visit to the next.

METHODS

Areas

The regular air surveys covered the entire west coast of Baja California and the Gulf coast from Cabo San Lucas to La Paz--also the east side of the Gulf, from Guaymas to Mazatlán (fig. 4). This coverage included all bays and lagoons in actual or potential use by breeding gray whales. Coverage of the east coast of Baja California, from La Paz to the head of the Gulf, was spotty and inconsistent from year to year, but all portions were covered carefully during one year or another. Any locality consistently used by numbers of gray whales would surely have been found. One survey on the coast of the mainland of Mexico went as far south as Puerto Vallarta, 200 miles south of Mazatlán, and another to Manzanillo, another 125 miles south, in latitude 18°N. No gray whales were definitely seen south of Reforma.

Procedure

The time selected for air surveys was February, after most gray whales had reached the breeding and calving bays and lagoons, and when only a few had departed for the north. Shore

counts, and estimates based on them, of total southward migration, indicate that over 90 percent of the northeast Pacific migratory population are in the aerial-census area at this time. Air censuses in the first three weeks of February appear to have been the most successful. The most favorable meteorological conditions for flight census were a strong, high-pressure area over the western United States which brought an easterly, or land breeze, from the interior to the coast of southern California and Baja California. This wind, locally called a "Santa Ana," pushed away the usual coastal fog and smoothed the water surface by counteracting the prevailing northwest wind. The best time of day for air surveys was morning when air was clearest, wind weakest, and surface visibility best. The position of the sun influenced visibility, but the plane could often be maneuvered to the sun-side of the migration path or lagoon.

The first air survey was carried out from a Cessna 170. Later a Cessna 180, or Piper Supercub with floats, and finally a Grumman Widgeon, a five-passenger amphibian, were used. The success of all flights can be attributed, in part, to the efforts of Dr. Gifford C. Ewing, owner and pilot of the aircraft.

The course of the aircraft in flight along the coast was one to three miles offshore, depending on the contour of the coast. It was closer to the headlands, farther out across the open bays and bights. The aircraft flew at about 90-knot speed at an elevation of 1,000 to 1,500 feet over the coastal waters. This altitude over the ocean gave fair coverage of a half mile or so on each side and allowed quick recognition of any whale below. When time pressed, speed was increased to 110 or 120 knots, and the altitude to 2,000 feet, without substantial loss of accuracy.

Over lagoons, the plane dropped to 500 or 750 feet. The lower altitude was high enough for lateral coverage because the channels were narrow, and yet was low enough for recognition of calves. Despite the low elevation, however, a certain number of calves were undoubtedly missed, even when their mothers were in full view at the surface. Rough water was particularly disadvantageous for spotting calves. Very young calves stayed close to the mother's side and, when nursing, were sometimes observed to be partially hidden by her. It is assumed that a few must have been entirely hidden.

In the lagoons, the period of time spent by a gray whale under the surface is extremely variable. A whale averages about four minutes below the surface, when it cannot be seen. It spends about a minute at or near the surface, blowing from two to four times. About one-fourth of the whales beneath the plane could perhaps be seen by the observers at any time.

RESULTS

Survey of 1952

An air survey was made in 1952, February 16-20, by Dr. Carl L. Hubbs and Dr. Gifford C. Ewing. As it was similar to later censuses, it has been included here (table 5) with the kind permission of Hubbs and Ewing. The entire west coast of Baja California was covered, including the principal lagoons and the Gulf coast from Santa Rosalia southward, although no gray whales were seen in the Gulf of California.

Survey of 1953

Two aerial surveys were made during the 1952-53 season. The first was made from January 31 through February 3, 1953. Although the season was early, the weather was excellent and the results were good. The flight was made in a Cessna 170. The entire west coast of Baja California was covered, except for the section from Laguna Scammon to Laguna San Ignacio and a small portion from Boca Las Animas to Boca Soledad, north of Bahía Magdalena.

TABLE 5.--SUMMARY OF AIR CENSUSES OF GRAY WHALES ON WINTER RANGE, 1952-57

Areas (see text)	1952[1]		1953				1954				1955		1956		1957	
	February 12-February 20		January 31-February 4		February 25-February 27		February 1-February 7 (incomplete)		February 15-February 18		February 26-March 3 (incomplete)		February 14-February 17		February 27-March 3	
	adults	calves	adults	calves	adults	calves	adults	calves	adults	calves	adults	calves	adults	calves	adults	calves
Northern migration area.....	14	-	82	1	19	3	-	-	-	-	[2] (15)	-	6	-	40	-
Vizcaíno breeding area.....	473	37	191	123	321	54	-	-	-	-	[3] [121]	[69]	319	82	320	53
Vizcaíno area of migrating and wandering.....	38	2	-	-	25	2	-	-	-	-	-	-	-	-	6	-
San Ignacio breeding area.....	146	4	54	22	65	8	(14)	-	-	-	54	32	71	14	81	16
San Juanico area of migrating and wandering.....	6	1	25	1	30	8	(19)	(5)	-	-	2	1	18	8	3	1
Magdalena breeding area.....	71	35	295	41	151	42	(153)	(36)	-	-	214	37	363	30	74	23
Cape area of migrating and wandering.	-	-	75	2	2	1	(5)	-	-	-	15	-	37	-	7	3
Yávaros breeding area.....	-	-	-	-	-	-	7	6	-	-	10	7	-	-	(1)	-
Reforma breeding area.....	-	-	-	-	-	-	18	12	-	-	2	1	5	4	2	2
Gulf area of extralimital wandering.	-	-	-	-	-	-	1	-	-	-	3	1	3	-	-	-
Pacific area of extralimital wandering.....	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(12)	(4)
Total.....	748	79	722	190	613	118	(217)	(59)	1,200	200	(315)	(79)	822	138	533	98

[1] Data from Carl L. Hubbs and Gifford C. Ewing
[2] Numbers in parentheses represent incomplete figures, not comparable.
[3] Numbers in brackets represent special counts made otherwise in air census. See text.

The second survey was made from February 25 through 27, 1953, in a Cessna 170. The entire west coast of Baja California from Cabo San Lucas to San Diego, was covered and also the Gulf side from Santa Rosalia about midway to the Cape.

Survey of 1954

The first air survey covered the dates February 1 through 7, 1954, and was made in a Piper Supercub with floats. However, the survey was incomplete because it was cut short at Laguna San Ignacio on the way north from La Paz.

A second air survey was carried out from February 15 through 18 by Hubbs and Ewing, who covered the same course as the earlier flight and completed the survey back to San Diego. About 1,200 adults and immatures and 200 calves were seen in this second survey.

Survey of 1955

The survey of 1955 was incomplete. The Grumman Widgeon developed motor trouble on March 4 and the survey was stopped just beyond San Ignacio on the west coast of Baja California. On February 26, a survey was made of the "Northern" area from San Diego to Ensenada. The survey covered the Gulf at Yávaros and Reforma, and the Cape, Magdalena, San Juanico, and San Ignacio areas from February 27 through March 3.

On February 4, 1955, Dr. Gifford C. Ewing, Dr. Fred Phleger, and Mr. Robert Lankford flew over Laguna Scammon and counted 121 adult or immature gray whales and 69 calves.

Survey of 1956

The survey of 1956 was conducted from February 14 through 17. The Grumman Widgeon, a twin-engine amphibian, was used again. Vision from the Widgeon was not as good as from the Cessna 170, the Cessna 180, or the Piper Supercub with floats. Operation of the plane required nearly all of the pilot's time and he was, thus, unable to participate in the census. A second watcher on the port side was added, although he was forced to look through a small window which limited his field of view.

During the 1955 flight, the plane had been maneuvered so that most or all of the whales could be viewed from the starboard side, where the writer sat. During the 1956 flight, attempts to place both port and starboard observers in an advantageous position resulted in fewer whales being seen by the two observers than by one in 1955. To eliminate the blind spot under the plane, a zigzag technique was tried which involved weaving back and forth in S-shaped curves over the channels of the lagoons. This made the count slow and interrupted as every other turn placed the observer on the high side of the plane where he was unable to see the water. The zigzag technique was thoroughly tested in Laguna Scammon and perhaps 30 percent of the whales, which otherwise would have been visible, were missed. Zigzagging was therefore abandoned.

Three areas were not covered during the 1956 survey (1) the entire Vizcaíno area; (2) the 130 miles of coast from Boca Las Animas to Boca Almejas outside the Magdalena area; and (3) about 50 miles of the coast on the Cape, west of the La Paz area.

Results of this air survey, based on a table prepared by the Fish and Wildlife Service, were published by Berdegué (1956).

Survey of 1957

The 1957 air survey of the winter grounds of Baja California and the Gulf of California was made by the Fish and Wildlife Service in cooperation with Scripps Institution of Oceanography and the Richfield Oil Company from February 27 through March 3, 1957. The Grumman Widgeon was

again used. The flight was made in good weather and provided excellent coverage, but the number of whales was disappointingly small.

SUMMARY OF AERIAL SURVEYS

Because the air-survey method introduced many variable factors, and information needed to apply corrections was not available, it is unwise to estimate the size of the total population on air-survey data. However, an air survey is the only way to determine the extent of breeding grounds, the relative use of areas as calving grounds, and changes from year to year.

The breeding areas may, as a result of the aerial surveys, be ranked as follows:

Vizcaíno-Scammon area.--This is the most important of the winter calving areas. During the five years of the surveys, it might have held numbers of whales varying from 1,500 to 2,000, or about half the total population.

Magdalena area.--This is the second most important calving ground. Perhaps 1,000 to 1,500 whales, or about one-third the total population, visited the area during each year of the 5-year period of the surveys.

San Ignacio area.--This is the third most important spot for calving and mating, with perhaps 500 whales, or between one-eighth and one-sixth the total winter population.

Reforma area.--The highest count made at one time here was 18 adults and 12 calves.

Yávaros area.--Evidently only small numbers of whales used the Yávaros area. The highest count was 10 adults and 7 calves.

The area available for calving and mating may be the most critical factor in determining eventual size of the population. Reduction of this area by natural (geological) events or by man may have a pronounced effect in lowering the population ceiling. Man-modified or man-disturbed lagoons and bays which should be carefully watched are Bahía San Quintin, Laguna Guerrero Negro, Bahía Magdalena, Bahía Reforma, and the Yávaros area. Continued studies of these areas will help to evaluate the relationship between gray whales and man (see table 5).

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